Exemption No. 7959

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98055-4056

In the matter of the petition of **Mitsubishi Heavy Industries, LTD.** for an exemption from SFAR No. 88 of Title 14, Code of Federal Regulations	**Regulatory Docket No. FAA-2001-13488**

PARTIAL GRANT OF EXEMPTION

By letter dated September 30, 2002, Mr. Yukihiko Nakata, Manager, Civil Aircraft Engineering Department, Mitsubishi Heavy Industries, LTD, 10, Oye-Cho, Minato-Ku, Nagoya, 455-8515, Japan, petitioned for an exemption from the requirements of Special Federal Aviation Regulation (SFAR) No. 88, "Fuel Tank System Fault Tolerance Evaluation Requirements" of Title 14, Code of Federal Regulations (14 CFR). This exemption, if granted, would allow Mitsubishi as the type certificate holder of the Model YS-11 series airplanes relief from the requirements of SFAR No. 88 which requires conducting a complete safety assessment and developing maintenance and inspection instructions and modifications.

The petitioner requests relief from the following regulations:

> **Part 21 SFAR No. 88** requires that each type certificate (TC) and/or supplemental type certificate (STC) holder to develop a report no later than December 6, 2002, that must:
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> (a) Provide a fuel tank system safety review that contains substantiation that the airplane fuel tank design, including all necessary design changes, meets the requirements of §§ 25.901 and 25.981(a) and (b), at Amendment 25-102; and

(b) Contain all maintenance and inspection (M&I) instructions established by the fuel tank system safety review. The instructions are necessary to maintain the fail-safe design features required to preclude the existence or development of an ignition source within the fuel tank system throughout the operational life of the affected airplanes.

Operators of airplanes that meet certain payload and passenger limits are obligated by the amendments to parts 91, 121, 125, and 129 of the operating rules to have an approved maintenance program for the fuel tank systems on their affected airplanes by June 7, 2004. That maintenance program will incorporate the M&I instructions created by the affected TC and STC holders from their SFAR No. 88 fuel tank system safety review(s) and as well as address the actual configuration of the airplane.

The petitioner's supportive information is as follows:

Background

The Mitsubishi Heavy Industry (MHI) Model YS-11 is a two-engine turboprop aircraft designed to carry up to 59 passengers plus the pilot and copilot. As certified, there are five YS-11 models: the Model YS-11, YS-11A-200, -300, -500 and -600. All U.S. operators use the Model YS-11-200, –300, or –600 airplanes.

The MHI records indicate almost all Model YS-11s are operated in Asia. A single U.S. operator, Texas based cargo company "Ferreteria E Imploementos," operates two Model YS-11 airplanes, serial number (S/N) 2173 and 2071, and has two additional Model YS-11 airplanes in storage, S/N 2050 and 2053. The newest airplane among these four was manufactured in 1973. The four Model YS-11 fuel systems are the same, with the exception of S/N 2173, which has an added feature of a bag tank. The two Model YS-11 airplanes in operation have a maximum monthly utilization of less than 35 hours and a maximum yearly utilization of less than 150 hours. Ferreteria E Imploementos does not plan to stop operating their two Model YS-11 airplanes since they provide a unique and cost effective means of commerce in South Texas.

Public Interest Considerations

Today the Model YS-11 is used by a very limited number of operators in cargo operation. The Model YS-11 cargo capacity and operating costs are favorable for specific markets. Users can take advantage of the unique services provided by the Model YS-11 operators and hold prices down, which benefits the public. The economic burden of full compliance with SFAR No. 88 would force the U.S. operator to take their Model YS-11 airplanes out of service. The advanced age and small number of U.S. registered airplanes would likely make compliance impractical from an economic standpoint.

Granting the requested exemption will not adversely affect safety. The Model YS-11 fuel tank system is a robust design that is maintained by the operators. Model YS-11

airplanes have accumulated over 7-million flight hours worldwide. The fuel system exhibits many of the design features that the FAA notes as improving safety in the advisory material accompanying SFAR No. 88. In lieu of full compliance with SFAR No. 88, MHI proposes an inspection program to determine the potential for failures that will be based on their investigation of a fuel tank system safety inspection of a high-time airplane in Japan. There is a possibility for some items to cause fuel vapor ignition in certain failure conditions. The MHI will issue maintenance and service information (service bulletins) for unsafe items discovered.

Should the current Model YS-11 fuel system design not meet the newly imposed requirements, redesign and modification of aircraft will be necessary. Wiring systems are particularly susceptible to damage if disturbed during maintenance or modification. Pulling wire bundles apart and disturbing connectors and wire bundle supports could result in damage that would be difficult to observe but could pose serious problems at a later time. Replacing all wiring impacted by modification to existing wiring runs would be extraordinarily expensive.

Safety Assessment Considerations

The fuel system design and operation has design features that provide protection against ignition and is an equivalent level of safety to the SFAR 88 requirement. What follows is a discussion of the current design features that provide protection against ignition. Where failure conditions can be hazardous, the details of the MHI proposed inspection program are given.

Fuel System Design

Basic Fuel System Description

There are two integral tanks and provisions for five optional bag tanks on the Model YS-11. Each integral wing tank is located in each outboard wing, two bag tanks are located in the inboard left-hand (LH) wing, and up to three bag tanks are located in the right-hand (RH) inboard wing. Integral wing tanks (No. 1 and 4) are interconnected to allow cross feed to engines. The transfer pump in the bag tank transfers fuel to each integral wing tank. The boost pump in the integral wing tank feeds the engine. [The complete analysis and description of the Model YS-11, as presented by MHI, is available in the docket.]

Normal and Emergency Procedures

The pilot verifies fuel quantity indicating system (FQIS) or pump operation failures from the flight deck indication (boost pump light, or fuel pressure warning light) in preflight. In flight, the pilot verifies pump operation failure by checking the fuel pressure warning light. If there is a failure of boost pump, the pilot can handle the safety operation in accordance with published emergency procedures.

Systems and Components Relevant to Fuel Tank System Safety

The wiring to/from the direct current (dc)/alternating current (ac) generator runs in front of the forward wing spar which is in front of the bag tanks. The fuel tank system wiring is separated from the generator wires because it is located behind the rear wing spar. Therefore, the location of these wires does not induce high voltage into the fuel tank wiring. The auxiliary power unit (APU) bleed air duct and the air conditioning packs are not located near the fuel tank.

Pumps

There are three types of pumps in the fuel tank system, boost pumps, transfer pumps, and scavenge pumps. Both boost and transfer pumps are powered by 28 volts, direct current (Vdc). The scavenge pump is powered by 26 Vdc. All pumps are bonded to the airplane structure.

1. Boost pumps. Two boost pumps are installed in each collector tank of the wing tank. In takeoff or landing both pumps are used, while only one pump is used during cruise. The boost pump delivers fuel from the collector tank to the engine and is electrically bonded by its twelve mounting bolts. The pump wire runs through aluminum conduit in the tank and is protected by a 15-amp circuit breaker. These wires have sleeving per the process specification to prevent wire from chaffing with conduit.

MHI proposal: To inspect a high-time aircraft to verify the boost pump bonding by measuring resistance (less than 0.01 Ohm) and the pump wire condition (see the discussion on wires in the sub-heading “Conduits”).

2. Transfer pump. A pump is installed in the auxiliary (AUX) bag tank. The transfer pump is the same type as the boost pump. This pump transfers fuel from the bag tank to the collector tank in the main (integral) wing tank. The pump wires run outside the bag tank.

MHI proposal: To inspect a high-time aircraft to verify the boost pump bonding by measuring resistance (less than 0.01 Ohm) and the pump wire condition (see the discussion on wires in the sub-heading “Conduits”).

3. Scavenge pump. An external scavenge pump is installed on the rear spar at the low point of the tank. The pump transfers fuel from the main (integral) wing tank to collector tank.

Fuel Quantity Indicating System (FQIS)

The FQIS is of capacitance type. There are three probes and a compensator in each main tank. For each bag tank there is one probe and a compensator. The fuel probes are supplied with 33.3 milli-amps and 50 volts under normal conditions. In transient conditions, the fuel probes reach a maximum of 36.98 milli-amps and 55.48 volts. The compensator is submerged beside the inter-most fuel probe. In normal and transient operation the compensator is supplied with 44.38 milli-amps and 66.57 volts.

MHI proposal: To inspect a high-time airplane to verify the FQIS wire condition.

Float Switch

Float switches are located in the main wing tanks and bag tanks and are supplied with 0.5 amp and 28 Vdc. The wire of the float switch runs through aluminum conduit. The float switch is bonded by contact with airplane structure.

MHI proposal: To inspect high-time airplane to verify bonding condition by measuring the resistance (less than 0.0025 Ohm) and float switch wire condition. (See later discussion on wires in the sub-heading "Conduits").

Valves

There are four types of valves in the fuel tank. They are the level control valve, vent float valve, pressure relief valve, and shutoff valve. By design, the valves are all mechanical systems and are bonded against buildup of a static charge. Level control valves and vent float valves are bonded by four bolts on contact with the airplane structure. The pressure relief valves and shutoff valves are bonded by contact with the airplane structure.

MHI proposal: To inspect this bonding (less than 0.005 Ohms) on high-time airplanes.

Fuel Filler Cap

These are mechanical components and properly bonded against buildup of static electrical charge by contact with 30 rivets. Fuel filler caps are located in "Lightning, Zone 3," as described in Advisory Circular 20.53A, and will not cause fuel ignition.

MHI proposal: To inspect this bonding (less than 0.005 Ohms) on high-time airplanes.

Switches

All switches, except for the float switch, are located outside the fuel tank.

Piping

1. Fuel pipes. All fuel pipes are bonded using bonding straps.

MHI proposal: To inspect bonding by measuring resistance (less than 0.01 Ohm). There is no refuel line, because the fuel is directly refilled through the refuel adapter located in the lower side of the wing trailing edge. The refuel adapter is electrically bonded by reliance on contact of the rivets and structure.

2. Vent pipes. All the vent pipes are electrically bonded using bonding straps. The vent flush intake adjusts the pressure inside the fuel tank by ventilating the fuel tank to outside air. Vent intakes are located in "Lightning Zone 3," and are electrically bonded by straps so that a flame arrestor does not need to be incorporated.

MHI proposal: To inspect bonding by measuring resistance (less than 0.01 Ohm).

3. Conduits. Conduits are used for boost pump and float switch wiring. The conduits are bonded.

MHI proposal: To inspect these bonds by measuring resistance (less than 0.0025 Ohm). Also, MHI plans to inspect edge of conduit by visual inspection to check for fuel leaks, which means there may be holes, or burn through, or cracks in conduit.

Others. There are level control valve pipes and vent float valve pipes incorporated in the fuel system. Both incorporate grounding straps per type design.

MHI proposal: To inspect this bonding (less than 0.005 Ohms) on high time airplanes.

Results of Investigation

Analysis and Examination

It has been shown that any leakage from the fuel tank or fuel lines will drain away from the airplane and will not result in an unsafe concentration of fuel vapors.

Lightning zones. The Civil Aviation Regulations (CAR) 4b did not require lightning protection for the fuel tank. However, in 1963 the Model YS-11 was analyzed to lightning protection criteria similar to 14 CFR 25.954 and Advisory Circular 20-53. The analysis found that MHI bonding complies with MIL-B-5087 and SAE ARP 1870.

Located in "Lighting Zone 3" is the vent flush intake. The lightning energy will not be transferred into the tank due to extensive electrical bonding in the basic design.

MHI proposal: To inspect the bonding on high time aircraft to determine condition.

External heat sources. Air conditioning ducts run about 14 inches aft of the bag tank. The maximum temperature of the air exiting the super charger is 383 °F.

Boost pump power feeder wire. Boost pump power feeder wires run through a metal conduit. There is a possibility of fuel vapor ignition by thermal spark in the conduit due to chafing and wear of this wire. However, the possibility of the feeder line's chafing or wear is very low because a protective sleeve covers the wire inside the conduit.

MHI proposal: To inspect high time airplanes for any chafing damage and to perform an isolation test, which consists of putting 500 Vdc to the pump wires, then measuring the resistance to structure. It should be over 10 mergOhm.

Dry running of transfer pump. When the fuel level is low and the bag tanks become nearly empty, a red warning light comes on to warn the pilot. The pilot turns off the transfer pump. This prevents the potential of sparking between pump impeller and debris while the pump is running in dry conditions.

MHI proposal: To have bag tank checked for debris and review AFM procedure to determine if additional clarification is required.

FQIS components. Each of the tank units and compensators energy in both normal and transient conditions are under 200 micro Joule.

FQIS wires. There are places on the airplane where FQIS wire is co-routed with 115 volts, alternating current (Vac). Most FQIS wiring is separated from high energy wiring except in one part of the fuselage. The FQIS wiring is bundled with other wires in the area around the wing and runs through the same conduit in the fuselage for approximately 20 feet.

MHI proposal: To inspect a high time airplane for chafing of these wires. The MHI is also planning an isolation test to check FQIS wires in conduits that are co-routed with 115 Vac wires.

Float switch wire. The float switch wire runs through metal conduits. There is a possibility of fuel vapor ignition by thermal spark in the conduit due to chafing and wear of the float switch wire covering. The wire has sleeving to prevent from chafing.

MHI proposal: To inspect high time airplanes using the isolation test and visual check at edge of conduit for fuel leaks.

Review of FAA Service Difficulty Reports (SRD)

The MHI asked five operators of the Model YS-11 if there are any service difficulty reports (SDR) for those items described in Advisory Circular 25.981-1B. The MHI obtained SDRs on 20 airplanes, with each airplane having from 19000 to over 50000 flight-hours. Some of the SDRs occurred between 1996 and 2002. The results of the SDRs found pump armature surface roughness, boost pump connector degrade, and a broken insulator on a fuel quantity probe.

Petitioner's Summary

Granting of this exemption request will not adversely affect safety. It is also in the public interest to maintain the service offered by the single Model YS-11 operator in the U.S. The MHI has verified through a detailed design review of the type design and service history and a preliminary inspection of an in-service airframe the fuel system of the Model YS-11. That it is of robust design and exhibits many design features which the FAA has noted as improving safety in the advisory material for SFAR 88.

The exemption from SFAR 88 of the Model YS-11 is in the public interest because compliance is impractical from an economic standpoint and it would remove the U.S. operator's service that currently provided at favorable rates and benefits to the public.

The exemption from SFAR 88 will not adversely affect safety because of the following reasons:

1. The MHI finds that the design of the Model YS-11 fuel tank system is safe from a detailed design review, a safety history, and an airframe inspection on airplane S/N 2181.

2. The MHI will inspect the high-time airplane (S/N 2152) in Japan on October 2002, for potential ignition sources. Also, MHI will inspect the bag tanks installed on the U.S. registered Model YS-11 (S/N 2173) because this is a unique installation.

3. The MHI will develop the maintenance requirements to deal with any unsafe items discovered, as mentioned in item (2), to prevent the potential for fuel explosion.

The complete analysis and description of the Model YS-11 as presented by Mitsubishi Heavy Industries, LTD, is available in the docket.

A summary of the petition was published in the Federal Register on November 20, 2002 (67 FR 15003). One supportive comment was received.

The FAA's analysis/summary is as follows:

The FAA has considered the information provided by the petitioner, and has determined that there is sufficient merit to warrant a partial grant of exemption.

Nature and Extent of Relief Sought

The petitioner requests an exemption from the requirements of part 21 SFAR No. 88 for all versions of the Mitsubishi Heavy Industries Model YS-11 airplane.

The petitioner intends to work directly with the active U.S. Model YS-11 operator in a mutual effort to review the fuel system maintenance performance in their Model YS-11 fleet. That effort would generate a recommended maintenance practice service letter for fuel tank safety. The expected completion date for this effort would be March 28, 2003. Also, the petitioner would accept restrictions on limiting operation of "N" registered Model YS-11 airplanes to those that are approved for all cargo operations only.

Information in Support of the Petition

The FAA concurs that the Model YS-11 is used today exclusively by a very limited number of operators in cargo operations on routes where the Model YS-11 cargo capacity and operating costs are favorable for their specific market. The FAA agrees that a petition for exemption is an appropriate avenue to address the petitioner's concerns supporting the exclusion of all Model YS-11 airplanes from compliance with SFAR No. 88. The petitioner's supporting data for cost of compliance is acceptable (available in the Docket), and commitment to work with active Model YS-11 operators to develop a recommended maintenance practice for the fuel tank system is recognized.

Comments in the Public Interest

The petitioner demonstrates unique circumstances that make granting the exemption in the public interest. The FAA notes the petitioner's observation that by denying the petition, a significant economic burden would be placed on the operator. The FAA is cognizant that the petitioner has completed an initial zonal safety assessment of the Model YS-11 fuel system design features (available in the Docket). The Model YS-11 design does not have center wing tanks and has not had any recorded service difficulty with the fuel system and fuel pumps to present. The FAA concludes that because of the uncomplicated, trouble-free fuel system design, small fleet size, and limited operation of these airplanes, the fuel system design of the Model YS-11 is acceptable with the restrictions and limitations below.

In consideration of the foregoing, I find that a partial grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. 40113 and 44701, delegated to me by the Administrator, Mitsubishi Heavy Industries, LTD, is granted a partial exemption from Title 14, Code of Federal Regulations, part 21, SFAR No. 88 (insofar as the SFAR addresses compliance with §§ 25.901 and § 25.981(a) and (b), as amended by Amendment 25-102), to the

extent necessary to allow Mitsubishi Heavy Industries, LTD, as the type certificate holder of the Model YS-11 airplanes, to meet the obligations of SFAR No. 88 without conducting a complete fuel tank safety review, and without developing the necessary design changes required by that safety review, with the following conditions and limitations:

1. A limitation to restrict operation of "N" registered Model YS-11 airplanes only to those that are approved for all-cargo operation. The limitation section of the airplane flight manual (AFM) must be revised to restrict all operations to cargo only no later than June 7, 2004.

2. Mitsubishi Heavy Industries, LTD needs to include the development of the following specific design changes, and maintenance and inspection instructions for the fuel tank system:

a. Development of a clean tank inspection procedure approved by the FAA office of the Transport Airplane Directorate. Thereafter, that clean tank inspection procedure must be placed on a regular program schedule acceptable to the FAA office of the Transport Airplane Directorate, and

b. Modification of the metal conduits with power wires in the fuel tank in a manner acceptable by the FAA office of the Transport Airplane Directorate. Thereafter, these metal conduits and power wires must be placed on a regular inspection program acceptable to the FAA office of the Transport Airplane Directorate.

3. Submit a report by March 28, 2003, as required by paragraph (c) of SFAR No. 88, for approval to the FAA office of the Transport Airplane Directorate. This report must contain the design changes, and maintenance and inspection instructions, discussed in paragraph 2 above, as well as those developed from the inspection of airplane serial number (S/N) 2152 and S/N 2173.

4. This exemption does not provide relief to operators of Mitsubishi Heavy Industries, LTD, Model YS-11 airplanes from the requirements in their respective operating rules (§§ 91.410, 121.370, 125.248, or 129.32). However, we find that the instructions developed by Mitsubishi Heavy Industries, LTD identified in paragraph 3 above substantially meet the requirements of the operating rules for the configuration analyzed by the type certificate holder. This finding is based on the same information discussed above in support of the petitioner's petition for exemption.

5. The operator is responsible for:

a. Developing any necessary additional instructions for maintenance and inspection for the actual airplane configuration, which may differ from the configuration analyzed by Mitsubishi Heavy Industries, LTD, and

b. Ensuring that the limitation specified in Condition 1 is incorporated into the ARM. The operator's maintenance program will not be eligible for approval without this action.

All reports pertinent to this exemption must be provided to the office of the Transport Airplane Directorate of the FAA.

Issued in Renton, Washington, on January 23, 2003.

/s/ Ali Bahrami
Ali Bahrami
Acting Manager
Transport Airplane Directorate
Aircraft Certification Service